Conservation of the critically endangered Jerdon's Courser *Rhinoptilus bitorquatus* in India

BNHS

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School of Animal and Microbial Sciences

Conservation of the critically endangered Jerdon's Courser *Rhinoptilus bitorquatus* in India. Final Report

AUTHORS

Panchapakesan Jeganathan & Asad R. Rahmani

Bombay Natural History Society

Rhys E. Green

University of Cambridge & The Royal Society for the Protection of Birds (RSPB)

Ken Norris

University of Reading

Chris Bowden, Simon R. Wotton & Debbie Pain

The Royal Society for the Protection of Birds (RSPB)

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FINAL REPORT

BNHS

UNIVERSITY OF CAMBRIDGE

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DECEMBER, 2004

BNHS Mission

Conservation of nature, primarily biological diversity, through actions based on research, education and public awareness

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SUMMARY

Jerdon's Courser *Rhinoptilus bitorquatus* is a nocturnally active cursorial bird, known to occur only in a small area of scrub jungle in Andhra Pradesh, India. Jerdon's Courser is listed as critically endangered by the IUCN and was thought to be extinct until its rediscovery in 1986. Its population size, distribution and habitat requirements are poorly known because of its elusive habits. To fill this lack of information, intensive field study has been done in and around the Sri Lankamaleswara Wildlife Sanctuary, Cuddapah district, Andhra Pradesh. A new method has been developed for detecting their presence by deploying tracking strips upon which the birds leave their distinctive footprints. The identification of the footprints were established by setting up infra-red cameras to confirm the identity of birds, which left tracks. Surveys using this method have detected the species in three new places.

The number of bushes and trees within a 10 m square plot on each strip, were counted and other attributes of vegetation and substrate in this area were described. Logistic regression models were used to describe the relationship between the tracking rate of Jerdon's Coursers and characteristics of the habitat around the strips, using ground based survey data and satellite imagery. The results show that Jerdon's Coursers have a strong preference for a particular density of scrub jungle habitat and are most likely to occur where the density of large (> 2 m tall) bushes was in the range 300-700 ha $^{-1}$,and where the density of smaller bushes was less than 1000 ha $^{-1}$.

The call of the Jerdon's Courser was previously unknown. A short disyllabic call attributed to the Jerdon's Courser was recorded and identified. Jerdon's Coursers only occasionally respond by calling back when a tape recording of their call is played. Nevertheless, tape playback transect method was designed to detect their presence by eliciting calls from the conspecifics in new areas.

As a part of dissemination of project results and public awareness initiatives, three training workshops were conducted. The participants in these workshops were mainly staff from the Andhra Pradesh Forest Department and local NGOs. Sound boxes containing the call of Jerdon's Courser have been widely distributed locally, together with details of the bird and its conservation requirements.

Anthropogenic activities, such as clearing the potentially suitable habitat of the Jerdon's Courser, overgrazing by livestock and probably under grazing too are all likely to deteriorate the Jerdon's Courser habitat. Since the knowledge of the species' distribution is incomplete, large-scale habitat mapping, followed by ground surveys to find the Jerdon's Courser in new areas is a high conservation priority. It is necessary to protect the Jerdon's Courser habitat outside the Sanctuary. Finally, for effective conservation of the Jerdon's Courser, it is recommended that there is an urgent need to carry out radio-telemetry studies to know the exact ecological requirements of this critically endangered bird.

CHAPTER 1
INTRODUCTION

The Jerdon's Courser *Rhinoptilus bitorquatus* (Blyth) (Charadriiformes: Glareolidae) is a small cursorial bird that inhabits open patches in the scrub jungle. It is nocturnal or crepuscular in habit. It was first described by T. C. Jerdon in c.1848. Till 1900, some birds were recorded near Pennar river and Godavari river valleys, and near Anantapur (Baker 1929, Ali 1977). Subsequently, efforts by various ornithologists to record this elusive species were unsuccessful (Whistler and Kinnear 1930, Ali 1933-34). Special explorations organised by the Bombay Natural History Society (BNHS) in 1975 and in 1976 in collaboration with the Smithsonian Institution, Washington and Word Wildlife Fund-India, respectively, did not achieve positive results (Ali 1977). This led to the belief that the Jerdon's Courser was extinct (King 1981; Ripley 1982). Finally, it was rediscovered near Reddipalli village, Cuddapah District, Andhra Pradesh in January 1986 (Bhushan 1986a). The area where it was rediscovered was designated as the Sri Lankamaleswara Wildlife Sanctuary for the Jerdon's Courser (Bhushan 1986b).

Fig. 1: Historical records of the Jerdon's Courser

The Jerdon's Courser has been observed regularly only at a few sites in and around the Sanctuary ever since it was rediscovered (Samant and Elangovan 1997). Except sight records, there is no data on current population size or geographical distribution. Furthermore, very little information is available on the ecology and habitat requirements of the Jerdon's Courser (BirdLife International 2001).

Since the Jerdon's Courser is believed to have a small and declining population, it is categorised as Critically Endangered by BirdLife International (2001) and also in the IUCN Red List (Hilton-Taylor 2000). Furthermore, the Jerdon's Courser is listed under Schedule I of the Indian Wildlife (Protection) Act 1972, and more importantly it is considered as priority species under the National Wildlife Action Plan (2002 – 2016) of the Government of India (Ministry of Environment and Forest, 2002).

PROJECT BACKGROUND AND OBJECTIVES

The project was funded by the Darwin Initiative for the Survival of Species, U.K. and was sponsored by the Andhra Pradesh Forest Department, University of Reading and the Royal Society for the Protection of Birds (RSPB). This project officially started in August 2000. The fieldwork phase of this project was initiated as a preliminary survey in Sri Lankamaleswara Wildlife Sanctuary, Cuddapah district from September 20 to October 6, 2000. Intensive fieldwork was started from December 2000.

The overall objective of this project was to undertake ecological research on the Jerdon's Courser to determine current population size and distribution, and identify current threats to the populations.

This involved six specific objectives:

(i) To design a proper and reliable census method,
(ii) To estimate the current population size and geographical range,
(iii) To examine habitat use to determine habitat requirements,

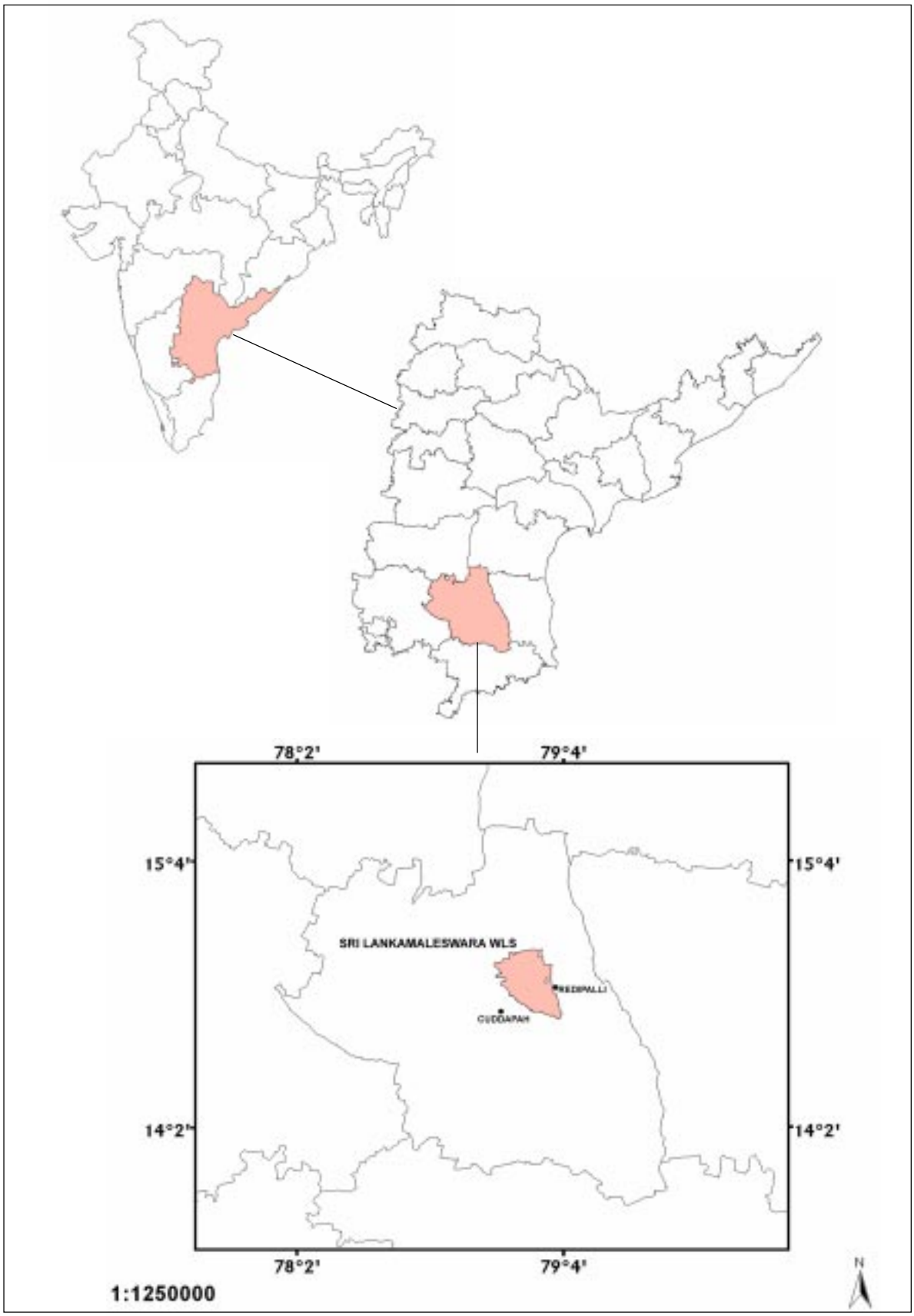


Fig. 2: Location of the Sri Lankamaleswara Wildlife Sanctuary in India

(iv) To train Andhra Pradesh Forestry Department staff in the collection and storage of key ecological information with respect to conserving Jerdon's Courser and also to transfer important skills necessary for long-term monitoring,

(v) To create public awareness both at local and governmental levels, to raise the profile of conservation efforts for Jerdon's Courser,

(vi) To develop management plans based on the research and monitoring work, which includes details of required conservation action, and a long-term monitoring programme.

STUDY AREA AND LAND USE

The study was conducted in the Sri Lankamaleswara Wildlife Sanctuary, in the valley of the River Sagileru, Cuddapah District, Andhra Pradesh, India (14°N, 79°E), as well as in similar habitat, outside the Sanctuary boundary and in the adjacent foothills.

Geographically, Sri Lankamaleswara Wildlife Sanctuary lies between the Nallamalais and Sechachalam hill ranges in the Eastern Ghats. The forest type in the study area is defined as southern tropical thorn scrub (Champion and Seth 1968). The study area was bordered in the west by dense scrub and dry red sanders-bearing forest as well as southern dry mixed deciduous forests on the higher elevations of the Lankamallai hills. To the east, agricultural fields, orchards and croplands are found.

Major vegetation in the scrub forest consist of *Acacia* spp., *Zizyphus rugosa*, and *Cassia carandes*, and the major tree species were *Hardwickia binata* and *Anogeissus latifolia*. Scrub jungle is followed by dry mixed deciduous consisting of *Pterocarpus santalinus* and *Terminalia* spp.

The scrub zone in the study area is traversed from west to east by streams that run during the monsoon season (May–October) and dry up during the rest of the year. Corridors of dense scrub and trees were found along the margins of these streams, with a mixture of open areas and scrub. The substrate consisted of alluvial soil, gravel or stones. The ground vegetation was sparse and dominated by grasses, which dry up during the dry season. The area was used by people from villages in the Sagileru valley for grazing herds of domestic Buffalo *Bubalus bubalis*, Sheep *Ovis aries* and Goats *Capra hircus* and for cutting wood.

A view of scrub jungle with open areas in Sri Lankamaleswara Wildlife Sanctuary

PREPARATION OF SOIL STRIPS

Stage 1. Soil strip is marked with a string and then 5 m long x 25 cm wide area is cleared of stones and vegetation.

Stage 2. Soil is levelled and sieved fine soil is laid along the line of a 5 m string to make sure that it is straight and of the correct length.

Stage 3. Fine soil is flattened into a strip 25 cm wide and 1-2 cm thick using a builder's trowel and the surface is smoothened.

Stage 4. A very thin layer of soil from near the site is dusted onto the surface of the strip from a sieve to camouflage the shining appearance.

CHAPTER 2
DEVELOPMENT OF CENSUS TECHNIQUE

METHODS

NIGHT SEARCH

The Jerdon's Courser is difficult to study because it is active nocturnally and the wooded nature of its habitat, together with its retiring habits, make visual searches in daylight unproductive. Earlier records of Jerdon's Coursers were obtained visually during night-time walks in lightly wooded scrub jungle in which the observer scans the ground with the aid of a torch (Bhushan 1986a). During our preliminary survey, a total of about 20 hours of night searching resulted in sighting of the Jerdon's Courser on two occasions. The searches were made in the area where sightings were more frequent. Moreover, the efficiency of night-time searching is unknown and is likely to vary with habitat characteristics, such as the density of bushes and the nature of ground vegetation. This makes the interpretation of negative results problematic.

SOIL STRIPS

Since it is not possible to follow the night search method in a large-scale survey, the soil strip method was developed, that retains the imprints of the feet of animals that walk over them. This method was used in surveys of the distribution of Jerdon's Courser, while species identity was confirmed by automatic cameras that were placed in areas where tracking indicated that the species was present.

Fine loose soil was obtained locally and passed through a 1 mm sieve. The soil was sieved so that most particles were <0.2 mm in diameter. Soil and sand with larger particles do not retain clear imprints, especially when dry. A strip of ground 5 m long and 25 cm wide was cleared of stones and its sparse covering of dried-out grasses.

The sieved soil was spread along the strip, flattened into a layer 1–2 cm thick, slightly compacted and then smoothed with a builder's trowel. Each strip required c. 25 kg of soil. A thin layer of soil, collected adjacent to the strip, was dusted onto the surface with a sieve to camouflage the difference in color that might otherwise cause birds to avoid the strip. The position of the strip was recorded using a global positioning system (GPS; Garmin GPS III).

AUTOMATIC CAMERAS

To confirm the presence as well as the footprint of the Jerdon's Courser, eight Trailmaster camera kits were used, each of which consisted of a TM1500 infra-red transmitter and receiver/logger, a TM35-1 camera, and connecting cable. Since the study area was used for fuel wood collection and cattle grazing by local people, the unit was set up at dusk and removed at dawn. The camera, transmitter and receiver/logger were installed on wooden stakes driven into the ground so that the infra-red beam would pass c. 12 cm above the ground. These camera units were set along with some of the soil strips. The camera was mounted in a protective shield at a height of about 70 cm and set in the direction of the line of the infra-red beam and the soil strip. So the picture and the footprint in the soil strip would confirm that the bird had crossed the soil strip and the infrared beam. The receiver/ logger was programmed to trigger the camera only between dusk and dawn, only if the beam was broken for at least 0.05 seconds, and not to take another photograph if the beam was broken again within one minute. The locations of the cameras were recorded with a GPS.

CHECKING OF TRACKING STRIPS AND RECORDING OF FOOTPRINTS

Tracking strips were usually checked at intervals of four days (range 1–7 days). Simulated bird footprints remained in good condition for at least eight days provided there was no rain. Tracks of birds were recorded, and photographs taken from directly above and/or Plaster of Paris casts were taken. Each visit to a strip when tracks were recorded is termed a tracking event, regardless of the number of footprints or their distribution on the strip.

If wind, rainfall, humans or livestock had disturbed a greater part of the strip, the period between such a visit and the previous one was excluded from the analysis. After each visit, the surface of a strip was smoothened.

A view of the tracking strip along with the receiver/camera at the one end and transmitter at the other end

Tracking strips were also placed to obtain the footprints of the other cursorial bird species such as Indian Courser (*Cursorius coromandelicus*), Red-wattled Lapwing (*Vanellus indicus*), Yellow-wattled Lapwing (*Vanellus malabaricus*), Painted Sandgrouse (*Pterocles indicus*), Chestnut-bellied Sandgrouse (*Pterocles exustus)*, Quail spp., and other Galliformes, which may have footprints similar to the Jerdon's Courser. This was achieved by looking for a field much frequented by that particular species and placing the strip there and also by baiting the gramnivorous birds with grains. Automatic cameras were also used to identify the species leaving footprints at some of these sites.

Plaster cast of bird footprints showing differences in angle and length of the toes

MEASUREMENTS OF MUSEUM SKINS

Initially, a list of bird species occurring in and around the known Jerdon's Courser habitat was compiled after surveying literature and by direct observation mainly to assess the possibility of other species that may have footprints that could be confused with those of Jerdon's Courser. Since Jerdon's Courser lacks a hind toe, all species with a hind toe were eliminated. Then measurements of the length of the central toe from museum skins were used to eliminate species whose footprints would be too small or too large to be confused with those of Jerdon's Courser. Two skins of Jerdon's Coursers were examined, one in the University Museum of Zoology, Cambridge, UK and one at the museum of the Bombay Natural History Society in Mumbai, India.

MEASUREMENT OF FOOTPRINTS

Footprints were measured on plaster casts and on photographs. Straight lines running along the central long axis of the imprints of each of the three toes were marked on the cast or photograph and the distances between the intersection of these lines at the hind margin of the foot (B) and points at the tips of the outer (O), central (C) and inner (I) toes were measured with Vernier Callipers to give distances BO, BC, BI respectively. For photographs, the distances were calibrated by a measuring scale marked in mm that was included in the photograph. The intersection point B coincides approximately with the hind margin of the foot. Using the intersection rather than the hind margin itself, allowed the measurement of footprints of running birds, which often do not leave a full imprint of the hind part of the foot. The distances between the tips of the outer and central (OC) and inner and central (IC) toes were also measured.

The angle between the long axes of the outer and central toes was then calculated as arcos ((BC 2 +BO 2 - OC 2)/ (2*BC*BO)) and the equivalent angle for the inner and central toes as arcos ((BC 2 +BI 2 -IC 2) /(2*BC*BI)). The angle between the outer and inner toes was the sum of these two angles. If there were measurements of more than one footprint from a given tracking event, means of those measurements were used in further analyses.

SURVEY TO KNOW THE TRACKING RATE OF THE JERDON'S COURSER

Initially, tracking strips and automatic cameras were placed in two areas of open scrub (JC1 & JC2), surrounded by denser shrubs and trees, where Jerdon's Coursers had previously been seen. Survey was conducted between January 30 and March 7, 2001. This was done to measure the tracking rate of the Jerdon's Courser in an area where it was known to occur and also to confirm the footprint of the Jerdon's Courser.

Footprint of the Jerdon's Courser (Rhinoptilus bitorquatus). *The labels O,C,I and B mark the tips of the outer, central and inner toes and the hind margin of the foot, respectively.*

RESULTS

CONFIRMATION OF THE FOOTPRINT

Automatic cameras operated for 42 camera-nights (22 in JC1 and 20 in JC2). Two photographs of Jerdon's Courser (at two sites in JC1), one of Stone Curlew and one of Red-wattled Lapwing were obtained. Footprints present in the soil strip were photographed and casts were also made whenever the soil strip coincided with the automatic camera. In this way, a set of tracks made by the Jerdon's Courser was identified from automatic photographs.

IDENTIFICATION OF FOOTPRINTS ON SOIL STRIPS

Measurements of two museum specimens of the Jerdon's Courser, which are in Mumbai and Cambridge, show that central toe lengths were 26.3 mm and 28.0 mm respectively. Examination of the feet measurements of other species, which are likely to be confused with that of Jerdon's Courser, revealed that some of them have either larger or smaller central toe length.

For most ground-dwelling bird species, further diagnostic analysis was made through the measurements from casts and photographs of footprints of known origin,

Trailmaster camera photograph of a Jerdon's Courser triggered when the bird broke an infra-red beam. The bird is leaving footprints across a tracking strip

Footprint confirmation of the Yellow-wattled Lapwing

made on tracking strips. Footprints of Barred Buttonquail (*Turnix suscitator*) were smaller than those of Jerdon's Courser whereas those of Stone Curlew and Red-wattled Lapwing were larger. In Indian Courser, Red-wattled Lapwing and,Yellow-wattled Lapwing, the angle between the outer and inner toes were larger than the Jerdon's Courser and in the case of Stone Curlew it was smaller. The outer and inner toes of Indian Courser were also shorter, relative to the central toe than that of Jerdon's Courser (Table 1, Fig. 3).

Footprints of Yellow-wattled Lapwing and Chestnut-bellied Sandgrouse might be mistaken for those of Jerdon's Courser. However, confusion with lapwing footprints is unlikely because the overlap in footprint characteristics between the two species is small (Jeganathan *et al*. 2002) and Yellow-wattled Lapwings are rarely seen in the types of habitat where Jerdon's Courser occur. Chestnut-bellied Sandgrouse were often seen in the study areas, but close examination of footprints of this species allows accurate identification.

Table 1. *Means of linear measurements (mm), toe length ratios and angles between toes (degrees) for Jerdon's Courser and other cursorial birds. Sample size* (n) *is the number of tracking events. Means were taken where more than one footprint was measured from the same tracking event.*

Species	Central toe		Outer toe		Inner toe		Ratio O:C		Ratio I:C		Angle O-C		Angle I-C		Angle O-I		n
	mean	SD	mean	SD	mean	SD	mean	SD	mean	SD	mean	SD	mean	SD	mean	SD	
Jerdon's Courser[1]	29.4	-	19.0	-	16.4	-	0.646	-	0.558	-	35.90	-	39.76	-	75.66	-	1
Jerdon's Courser[2]	-	-	-	-	-	-	0.657	-	0.604	-	40.12	-	40.22	-	80.34	-	1
Jerdon's Courser[3]	28.27	1.91	20.03	1.73	18.42	1.27	0.712	0.057	0.657	0.038	36.07	2.94	40.52	4.28	76.60	5.89	15
Indian Courser	28.71	1.93	16.86	1.66	14.56	1.73	0.587	0.033	0.506	0.041	43.59	7.50	52.47	7.68	96.06	4.65	18
Yellow-wattled lapwing	28.97	1.68	21.08	1.39	17.48	0.95	0.728	0.034	0.604	0.024	46.21	6.99	51.35	4.36	97.56	9.47	14
Red-wattled lapwing	37.72	1.02	29.05	0.91	24.15	1.18	0.771	0.034	0.641	0.033	48.75	5.15	50.79	7.08	99.54	9.27	17
Stone Curlew	39.44	1.52	29.89	1.88	24.90	2.32	0.758	0.031	0.630	0.042	31.86	6.33	25.46	2.85	57.32	7.23	12
Barred Buttonquail	23.34	0.85	18.83	1.05	14.65	0.80	0.807	0.027	0.628	0.018	42.43	0.77	42.71	1.93	85.14	2.7	6

[1] From a 35 mm transparency of a two footprints made by a Jerdon's Courser photographed crossing a tracking strip on February 14, 2001.

[2] From a colour print photograph of two footprints made by a Jerdon's Courser photographed crossing a tracking strip on February 14, 2001. A scale was not present in this photograph, so absolute measurements of toe length could not be calculated.

[3] From plaster casts, 35 mm slides and photographs of tracking events attributed to Jerdon's Courser on the basis of resemblance to the events labelled 1 and 2 in this Table. A scale was not included in photographs, so toe lengths are based upon 13 samples.

Footprints of other cursorial bird species which lack the hind toe, recorded on the soil strip, in and around Sri Lankamaleswara Wildlife Sanctuary

Footprint of the Indian Courser (Cursorius coromandelicus)

Footprint of the Red-wattled Lapwing (Vanellus indicus)

Footprint of the Yellow-wattled Lapwing (Vanellus malabaricus)

Footprint of the Stone Curlew (Burhinus oedicnemus)

Footprints of the Barred Buttonquail (Turnix suscitator)

Footprints of the Chestnut-bellied Sandgrouse (Pterocles exustus)

Museum skins of Painted Sandgrouse and Chestnut-bellied Sandgrouse showed that both species have similar feet measurements, and a distinctive wide pad (5-6 mm) is present at the junction of the toes. Tracks of Chestnut-bellied Sandgrouse, obtained on the tracking strip, showed these pads clearly. Apart from this, other diagnostic characters are: different position of the junction of toes with the pad, and distinctive drag marks from the claw of the central toe of the Chestnut-bellied Sandgrouse. So it was considered that tracks of this species could be separated from those of Jerdon's Courser on this criterion. Painted Sandgrouse were rarely seen in the study area and were relatively less abundant than Chestnut-bellied Sandgrouse.

TRACKING RATE IN THE KNOWN JERDON'S COURSER AREA

Footprints of three Charadriiform species, Jerdon's Courser, Stone Curlew and Red-wattled Lapwing, were observed on the tracking strips set in the two small patches of scrub jungle where Jerdon's Courser had previously been seen (Table 2). We were able to record 24 tracking events attributed to Jerdon's Courser on 11 of the 18 tracking strips, with a maximum of four events occurring on the same strip.

***Table 2**. Numbers of tracking events attributed to Jerdon's Courser, Stone Curlew and Red-wattled Lapwing for 18 tracking strips set in two patches of scrub jungle in which Jerdon's Courser was known to occur by direct observations. Monitoring of strips covers the period January 31 to April 8, 2001.*

Species	Site	Strip-nights	Tracking events	Events per strip-nights
Jerdon's Courser	JC1	420	17	0.04048
	JC 2	361	07	0.01939
	Both	781	24	0.03073
Stone Curlew	JC 1	420	53	0.12619
	JC 2	361	35	0.09695
	Both	781	88	0.11268
Red-wattled Lapwing	JC 1	420	32	0.07619
	JC 2	361	28	0.07756
	Both	781	60	0.07682

DISCUSSION

The presence of Jerdon's Courser can be detected both by automatic cameras and by tracking strips and the probabilities of detecting Jerdon's Courser per night of monitoring with a single camera or a single strip were similar. However, it would be difficult to accomplish a large-scale systematic survey of Jerdon's Courser distribution using cameras alone. Not only are the camera kits costly, but also in areas frequently visited by people and livestock, it is necessary to remove and redeploy the equipment at dawn and dusk every day.

In areas where Jerdon's Courser is known to occur, tracks were recorded on an average of one in thirty soil strip nights. Based on this result it was decided that, in order to infer absence as well as presence of Jerdon's Coursers in potentially suitable habitat, 20 tracking strips should be placed in a regular square grid of 50 or 100 m interval and it should be monitored for at least 23 nights (Jeganathan *et al*. 2002). This survey had a 1% chance of error, while determining whether the Jerdon's Courser was present or absent in the area covered by the grid. So, a more practical procedure would be to use tracking strips for a large-scale survey, but in an area in which tracking events are attributed to Jerdon's Courser, automatic cameras should be deployed as soon as possible to confirm the identification.

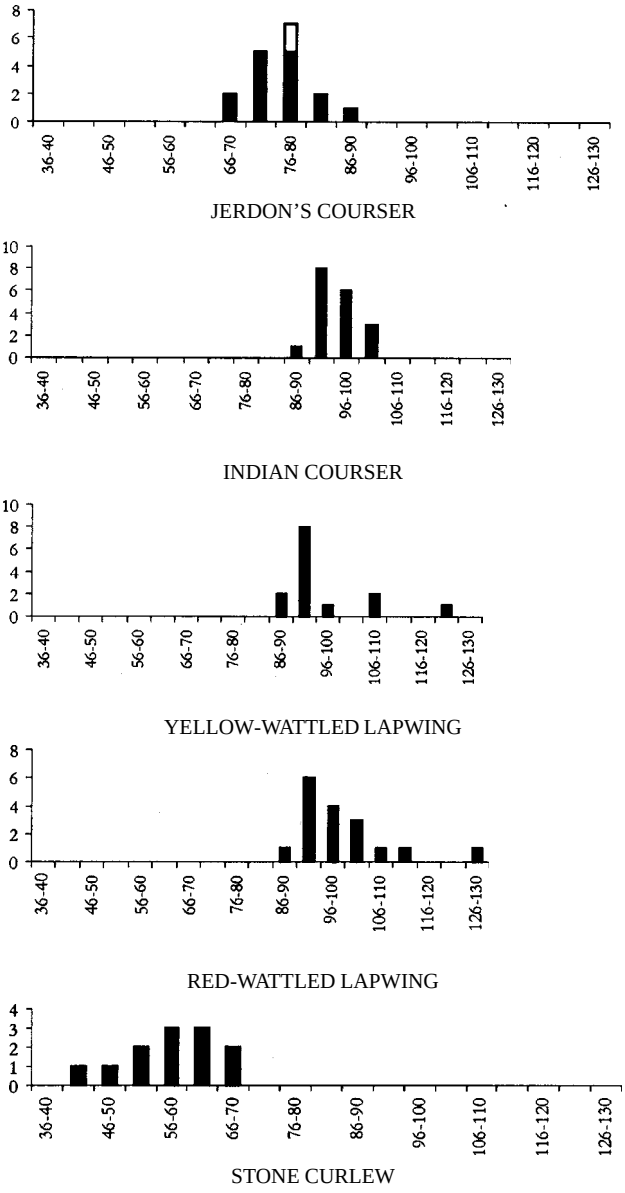


Fig 3: Frequency distributions of mean angles (x-axis) between the outer and inner toes from plaster casts and photographs of footprints of five bird species, in 5-degree bins (y-axis). For Jerdon's Courser, two tracking events for which the species identity was confirmed by automatic camera photographs are shown separately (white bar) from 15 events classified as Jerdon's Courser by resemblance to the confirmed tracks (black bars).

CHAPTER 3

RECORDING AND IDENTIFICATION OF THE CALL OF THE JERDON'S COURSER

The call of the Jerdon's Courser was not known previously, the only published reports on its calls are "a plaintive cry" (Ali and Ripley 1983), "very sad; a single note and very soft" (Bhushan 1990), "not very vocal; plaintive cry: he-he-he-he-he" (Kazmierczak and van Perlo 2000) and "kwick- kweek- kwick- kweek-kweek- kweek-kweek", as described by some bird trappers (Samant and Elangovan 1997). The latter description, however, was thought to be more likely to be that of the Stone Curlew *Burhinus oedicnemus* (Samant and Elangovan 1997).

Call recording was carried out because recorded calls can be used in tape playback method to elicit responses of nocturnal and secretive bird species. This method has been followed to gather information on the distribution, population estimation, relative abundance and density of several bird species (Francis and Bradstreet 1997, Hill and Lill 1998a, Legare *et al*. 1999, Ishtiaq and Rahmani 2000). Recorded calls can be used for individual recognition (Hill and Lill 1998b) and also for censusing (McGregor and Byle 1992, Gilbert *et al*. 1994).

METHODS

CALL LISTENING AND RECORDING

Since the Jerdon's Courser is nocturnal, efforts were made to listen for, and record, its calls during dawn and dusk in the places where it was known to occur, in the Sri Lankamaleswara Wildlife Sanctuary. Calls were monitored from about sunset to about 80 minutes after sunset, and from about 80 minutes before sunrise up to sunrise. To discriminate the Jerdon's Courser calls from those of the other birds in the Sanctuary, it was necessary to eliminate the calls of other species. Other crepuscular and nocturnal species that are now known to occur in the study area are Red-wattled Lapwing, Stone Curlew, Eurasian Eagle Owl *Bubo bubo*, Collared Scops Owl *Otus bakkamoena*, Spotted Owlet *Athene brama*, Indian Jungle Nightjar *Caprimulgus indicus*, Jerdon's Nightjar *Caprimulgus atripennis*, Common Indian Nightjar *Caprimulgus asiaticus* and Franklin's Nightjar *Caprimulgus affinis.* Since the beginning of the study, the calls of these species have been recorded and catalogued along with the calls of other species occurring in the Sanctuary, which could possibly be confused with that of the Jerdon's Courser.

The recording equipment used was a Marantz PMD222 tape recorder with an Audio Technica AT815 unidirectional microphone, with no sound filters. Searches, listening and recording were carried out mainly during clear still nights. Recordings of calls were analysed using the Canary 1.2.4 sound analysis package (Charif *et al.* 1993)

RESULTS

RECORDING AND IDENTIFICATION OF THE CALL

A call of the type that was later attributed to the Jerdon's Courser was heard on February 2001 and a Jerdon's Courser was sighted in the direction of the call a few seconds later. Identical calls were heard again on June and October 2001, but no birds were seen and no recordings were obtained during these occasions. The call was heard from places where the bird was seen to walk or fly within a few seconds. The first recording of the call was obtained during November 2001 and final confirmation that the call was made by a Jerdon's Courser was obtained on May 2002 when a Jerdon's Courser was observed while it was calling, before dusk and in ample sunlight (Jeganathan and Wotton 2004).

DESCRIPTION AND ANALYSIS OF THE JERDON'S COURSER CALL

The short disyllabic call consists of a high-pitched first syllable, and rapidly descending second syllable, which can be rendered as either "kwik-koo ... kwik-koo ... kwik-koo ... kwik-koo..." or "yak-wak ... yak-wak ... yak-wak ... yak-wak..." Each pair of syllables is referred as a call.

Spectrogram analysis of a single Jerdon's Courser call, consisting of two repeated syllables, each separated by an interval of 60 milliseconds (ms) shows that the majority of the energy within the call occurs between 1 and 4 kHz, with the syllables showing three distinct bands throughout the frequency range. In effect, there are three notes at three different frequencies (1 kHz, 2 kHz, 3.5 kHz), which make up each syllable. The calls are repeated in a series with gaps of about 500 ms between the end of one call and the beginning of the next (Fig. 4).

CALLING BEHAVIOR

Jerdon's Courser has been heard to give between 2 to 16 calls in a sequence, at a rate of about one call per second. The calling period is quite brief, starting 45-50 minutes after sunset and continuing for a few minutes to about 20 minutes. It has been estimated that the call can be heard from a distance of 200 to 250 m. It seems that the birds call mainly at dusk, but the frequency of calling is likely to depend upon the time of the year and the weather.

DISCUSSION

The recorded call does not closely resemble any of the previous verbal descriptions. These may refer to calls not detected so far, or the previous identifications may have been mistaken. The identified call of the Jerdon's Courser may be of value as it could help to find the bird in new areas and estimate its population size. It seems that Jerdon's Coursers call mainly at dusk and it may be possible to survey their distribution by listening for the calls. Standard playback method was used (see Chapter 4) to determine whether tape playback could be used to elicit calls over a longer period.

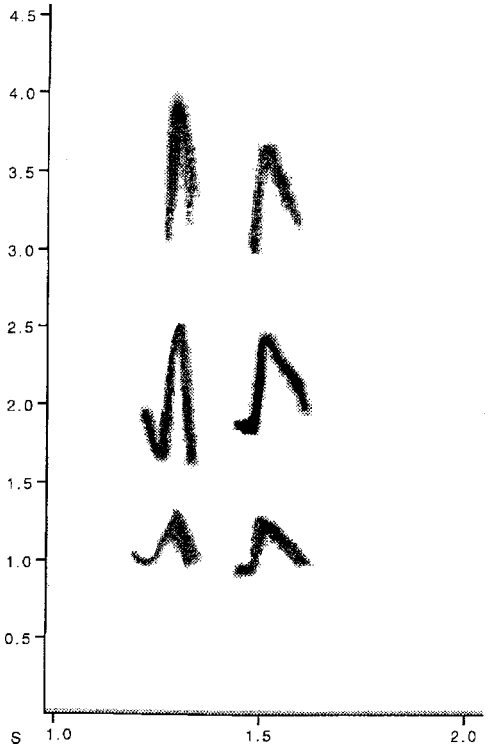


Fig. 4: Spectrogram (time v. frequency) of a complete Jerdon's courser call showing two syllables separated by an interval. The spectrogram was produced by Canary 1.2.4, grid resolutions 5.8 ms, 10.77 Hz. [Y- axis=kHz, X-axis=S]

Call of the Common Indian Nightjar Caprimulgus asiaticus *was also heard in the study area*

CHAPTER 4

SURVEY TO LOCATE THE JERDON'S COURSER IN NEW AREAS

METHODS

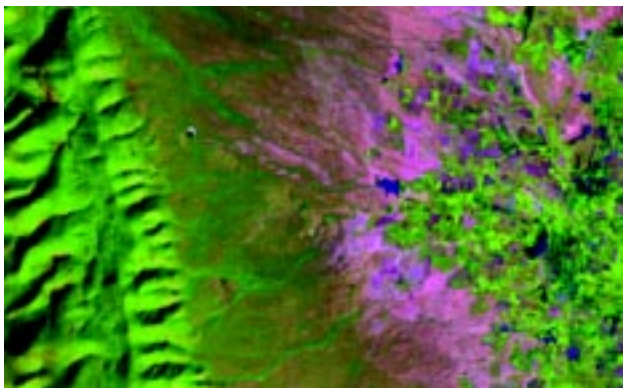
Ever since the Jerdon's Courser was rediscovered, it has been sighted regularly only at few sites in and around the Sri Lankamaleswara Wildlife Sanctuary (BirdLife International 2001).One of the main objectives of this project is to find the Jerdon's Courser to estimate the geographical range. Having developed the soil strip method and the diagnostic method to identify the tracks of the bird footprints, surveys were conducted to locate the Jerdon's Courser in new areas by following these methods.

Call of the Jerdon's Courser was not known previously and it was recorded and identified during this study (Jeganathan and Wotton 2004). The recorded call of the Jerdon's Courser may be of value since it could help find the bird in new areas and estimate its population size. Initially, tape playback was carried out at known Jerdon's Courser areas to know the rate at which it responsed to its own call. Also a tape transect survey method was devised to find the Jerdon's Courser in new areas.

SELECTION OF SOIL STRIP LOCATIONS THROUGH SATELLITE IMAGERY

Georeferenced Landsat 7 Enhanced Thematic Mapper image of the study area (path/ row 143/050) for December 6, 2000 was used to identify the extent of the potential habitat of the Jerdon's Courser in and around Sri Lankamaleswara Wildlife Sanctuary. An extensive ground truthing survey was carried out with the help of hard copy of the False Color Composite (FCC) of this image. By this method, different forest types in the study area were interpreted. In FCC (Band combination - 5, 4, 3) the place where the Jerdon's Courser is known to occur appears in purple colour. A rough map was produced based on the tonal similarities of the known Jerdon's Courser site and soil strips were deployed in similar habitat present in and around the Sanctuary.

Strips were deployed in 2001 and 2003 in 21 blocks of scrub jungle. Within each of these blocks, strips were placed on a square grid with 50 m or 100 m spacing.



False Colour Composite (FCC) of the Landsat TM7 satellite imagery of the study area

Agricultural landscape as shown above appears light green in the FCC

A view of the thick forest which appears dark green in the FCC

Scrub jungle habitat as shown above appears purple in the FCC

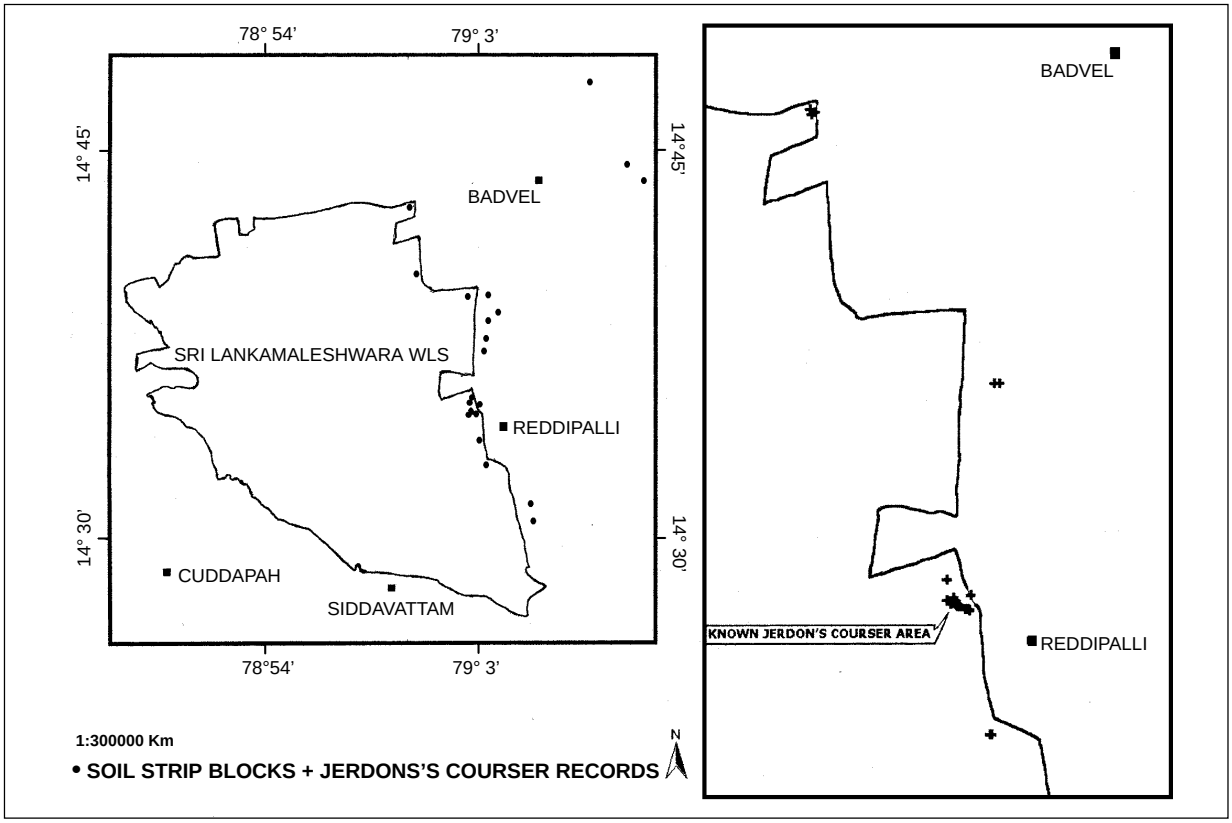


Fig. 5: Jerdon's Courser records in and around the Sri Lankamaleswara Wildlife Sanctuary

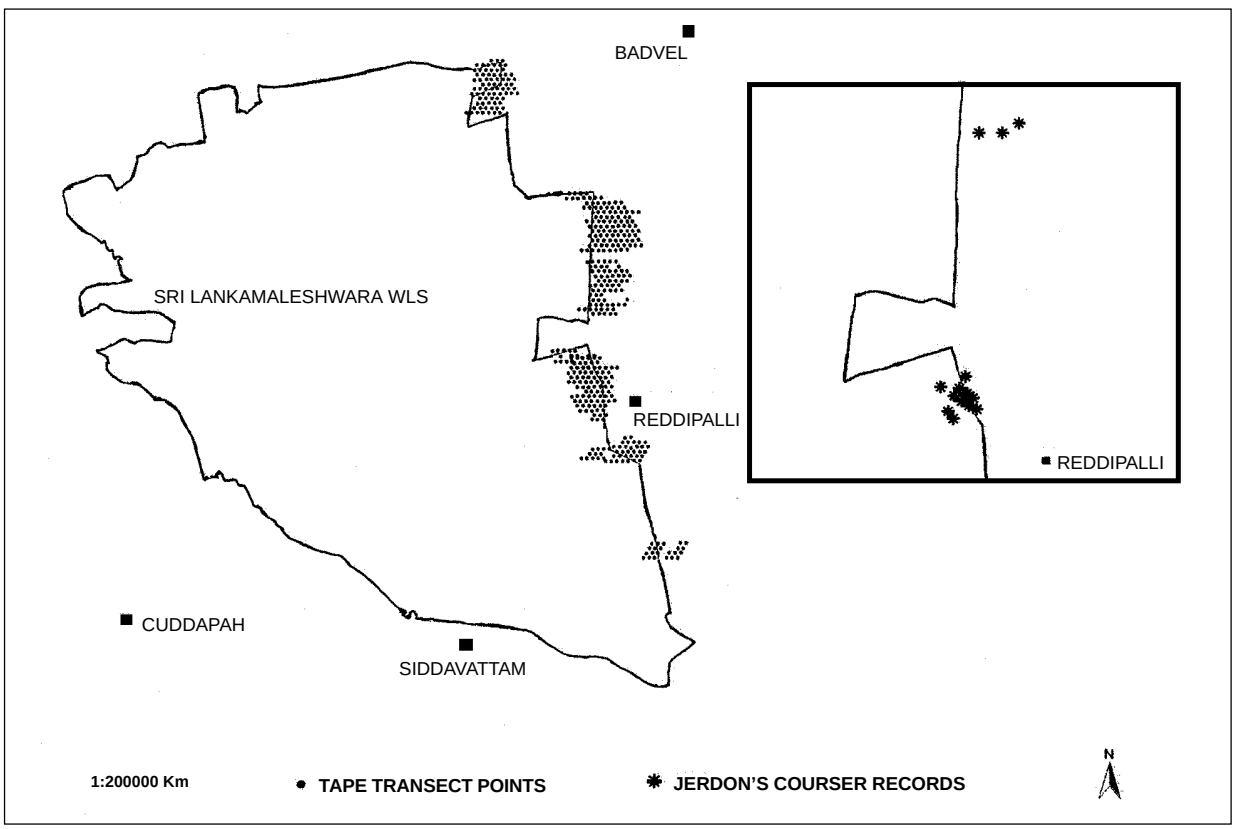
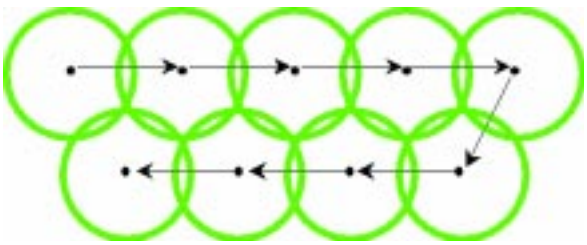


Fig. 6: Tape transect points and Jerdon's Courser records

Three blocks of soil strip were placed in the known Jerdon's Courser areas as well in a regular square grid. The grids were laid out within irregularly shaped areas of apparently suitable habitat using a GPS. Each strip was placed as near as possible to the place specified by the grid, but a few strips were displaced by a few metres if the specified place coincided with a large bush or tree. Apart from these necessary displacements, strips were deployed at random with respect to habitat within all blocks.

TAPE PLAYBACK METHOD

Tape transects involve, playing a standard one minute duration tape loop cassette with 4 bouts of calling, each of 10 calls at *c*. 1 second intervals, each bout separated by 5 seconds of silence, from a fixed point in scrub jungle. This tape was played for one minute at each place, on a double-speaker portable cassette player. The tape was played in all the directions for each bout of ten calls. The observer then listened for a minute before moving on to another point. The bearing, range and duration of calling by Jerdon's Courser were recorded. Points at which tapes are played were arranged on a regular grid with 260 m spacing. This design ensured that no point in the surveyed area was more than 150 m from a tape-playing place (Fig. 7). Tape transects began 45 minutes after sunset and continued for 45-50 minutes.



●- *Tape transect point*
◄----- *Distance between two tape playing points (260 m)*

Fig. 7: Diagrammatic representation of the tape transect design

RESULTS

DISCOVERY OF THE PRESENCE OF THE JERDON'S COURSER IN NEW AREAS BY MEANS OF FOOTPRINTS

Footprints of Jerdon's Courser were recorded on a total of 13 tracking strips in six of the 21 blocks. These are new localities for Jerdon's Courser. Three of the blocks with new records are within 1 km of the previously known site, the other three are 15, 7 and 4 km from it and one lies outside the boundary of the sanctuary (Fig.5).

ELICITING RESPONSES BY TAPE PLAYBACKS

Trials of playing a tape recording of Jerdon's Courser calls in suitable habitat within about 1 km of the previously known site during the evening (45-90 minutes after sunset) elicited responses from Jerdon's Courser from nine new places. Playing the tape recording of Jerdon's Courser at places where the species had been heard previously elicited responses on about 8% of occasions. Apart from this, tape transect surveys were carried out outside the known area in potentially suitable habitat in and around the Sanctuary. Tape playback was carried out at 421 points. These points were surveyed once and the Jerdon's Courser responded only at three points, (Fig. 6). Tape play back was also carried out in 67 points mainly in the places where Jerdon's Courser was recorded by means of footprints. These points were surveyed six times but no response from the Jerdon's Courser was elicited.

DISCUSSION

Visual records of Jerdon's Courser are difficult to obtain and require time-consuming searches by night. The monitoring of tracking strips has several advantages as a method for determining the presence as well as the absence of the secretive and nocturnally active Jerdon's Courser. Soil strip and tape playback methods can be useful for mapping the Jerdon's Courser's geographical range. Apart from this soil strip may also have useful applications in other aspects of the study of Jerdon's Courser, such as the quantification of habitat and microhabitat use and selection. The known range of the species will increase, if more extensive surveys are carried out with the help of habitat suitability maps produced from satellite imagery.

Tape playback is relatively quicker, when compared to soil strip method to survey large areas. It is difficult to estimate the population size by following the soil strip but the call of the Jerdon's Courser may be of value as it could help to find the bird in new areas and estimate its population size. Calling as well as response rate might be influenced by environmental conditions, time of day and the year. It was also not known whether some of the birds actually present did not call or whether only one sex calls.

CHAPTER 5

HABITAT REQUIREMENT OF THE JERDON'S COURSER

The Jerdon's Courser has been sighted mainly in the scrub jungle with open areas but information on its habitat preferences is not quantitative and is sparse (Bhushan 1990, BirdLife International 2001). The two other African congeners of the Jerdon's Courser, Three-banded Courser *Rhinoptilus cinctus* (Heuglin) and Bronze-winged Courser *Rhinoptilus chalcopterus* (Temminck), mainly prefer lightly wooded habitats and scrub (Maclean 1996). Habitat selection by birds is fundamental to understanding their biology and management (Cody 1985). Studying habitat selection would help ascertain important habitat features preferred by the target species for nesting, foraging, and roosting (Green *et at.* 2000, Lombardini *et al.* 2001).

Determining the habitat requirements would be helpful in mapping potentially suitable habitat and focus ing conservation efforts in high priority areas. It is imperative to know the distribution of the suitable habitat to conduct surveys and to conserve it, especially for a critically endangered species (BirdLife International 2001).

Habitat selection and distribution of birds may be related to the structure of vegetation (Cody 1985). To study the selection of habitat and to quantify the features of scrub jungle that correlate with the extent of its use by Jerdon's Courser, soil strip method, which retains characteristic footprints of Jerdon's Courser (Jeganathan *et al*. 2002) was used.

METHODS

Within a 10-m square plot centered on each of the 157 soil strips (11 blocks) (Table 3), all bushes and trees were assigned to 1 m height classes with the help of a calibrated stick, and identified to species. Specimens were taken and compared with herbarium material to confirm their identity. Visual estimates to the nearest 5% were made of the proportion of the substrate within the square that was soil, gravel and stones and the proportion of the square covered by grasses. Signs of woodcutting by humans, such as recently cut branches and trunks were also recorded.

SATELLITE IMAGE ANALYSIS

Georeferenced Landsat 7 Enhanced Thematic Mapper image of the study area (path/ row 143/050) for December 6, 2000 was used for analysing the reflectance values. This image was selected because it was cloud-free, close in time to the study period and obtained in the dry season when there is marked contrast in the appearance on the image of bushes, which bear green leaves, and the ground layer, which is bare soil or stones and sparse grass.

Reflectance values were analysed in all nine available bands (bands 1, 2, 3, 4, 5, 6·1, 6·2, 7, 8) for the pixel the centre of which was nearest to the tracking strip. Pixels were 14 sq.m. for the panchromatic band 8, 57sq.m. for thermal bands 6·1 and 6·2 and 28·5 sq.m. for the other bands. In addition to using the reflectance values themselves, we also calculated a Normalized Difference Vegetation Index (NDVI) as:

NDVI = (band 4 - band 3)/(band 4 + band 3)

Other studies show that this index is strongly correlated with the biomass density of green vegetation in the pixel (Curran 1980).

***Table 3**. Deployment of tracking strips and records of tracks of Jerdon's Courser in the 11 out of 21 blocks shown in Fig. 5.*

Block	First strip deployed	Last check	Strips	Strip-nights	Jerdon's Courser tracking events	Strips with Jerdon's Courser tracks
A	February 19, 2002	March 6, 2002	14	231	3	3
B	December 9, 2001	February 18, 2002	17	430	3	2
C	December 7, 2001	February 21, 2002	12	465	0	0
D	February19, 2002	March 28, 2002	16	555	0	0
E	April 11, 2002	May 3, 2002	12	247	1	1
F	February 27, 2002	May 4, 2002	15	771	1	1
G	April 8, 2002	May 25, 2002	11	334	4	4
H	January 30, 2001	June 13, 2002	18	863	27	11
I	April 25, 2001	June 6, 2001	16	448	0	0
J	December 8, 2001	February 21, 2002	10	324	0	0
K	December 8, 2001	February 20, 2002	16	487	3	2
Total			157	5155	42	24

STATISTICAL ANALYSIS AND HABITAT MODELLING

Bush species composition was analysed by performing Principal Component Analysis. The 12 most abundant tree and bush species in 157 plots was combined and was expressed as the number of individuals of each species in each plot as a proportion of the plot total for those species. Logistic regression models were used for describing the relationship between tracking rate of Jerdon's Courser and characteristics of the habitat around the strips, using ground based survey data and satellite imagery.

RESULTS

VEGETATION AND GROUND COVER OF SURVEY SITES

The relative abundances of the 12 most common bush and tree species are shown in Fig. 8. Details of plant names are given in Table 4. The dominant woody vegetation in the survey plots was shrubs, particularly *Zizyphus rugosa*, *Carissa carandas* and *Acacia horrida*. Most bushes were <2 m tall (Table 4) and *Hardwickia binata* was the only common species that often exceeded 4 m in height. Evidence of cutting of trees and bushes by humans was visible in >60% of survey plots in all blocks. Grasses covered about half of the ground surface. The main substrate types were stones (*c.* 40%) and fine soil (*c.* 60%).

Hardwickia binata *is common in the scrub jungle*

Table 4*. Correlations of species abundances with the first three principal components from an analysis of the proportions of the 12 most abundant tree and bush species in the study areas. Proportions were arcsine square root transformed before analysis.*

Species	PC1	PC2	PC3
Zizyphus rugosa	-0.561	0.269	0.672
Carissa carandas	-0.268	-0.687	-0.061
Acacia horrida	-0.100	-0.445	-0.563
Randia dumetorum	-0.082	0.532	-0.377
Tarenna asiatica	0.771	0.085	0.077
Hardwickia binata	-0.009	0.228	-0.242
Maytenus emarginata	0.289	-0.561	0.266
Canthium parviflorum	0.317	-0.072	-0.507
Ixora pavetta	0.547	-0.103	0.311
Diospyros ferrea	0.819	0.147	0.057
Grewia rhamnifolia	-0.269	0.595	-0.167
Pleiospermium alatum	0.732	0.250	0.047

TRACKING RATE IN RELATION TO VEGETATION AND SUBSTRATE

Logistic regression analysis was carried out in which the probability per soil strip-night of a Jerdon's Courser tracking event was modelled in relation to all of the variables listed in Table 5. Fig. 9 shows that strips tracked by Jerdon's Coursers tended to have low densities of small and large bushes and PC3 scores below the overall median. Fig. 10 illustrates the humped relationship between tracking rate and the density of large bushes. Comparison of mean percentage composition of common bush species in plots where the strip was or was not tracked by Jerdon's Courser indicated a lower relative abundance of *Zizyphus rugosa* at

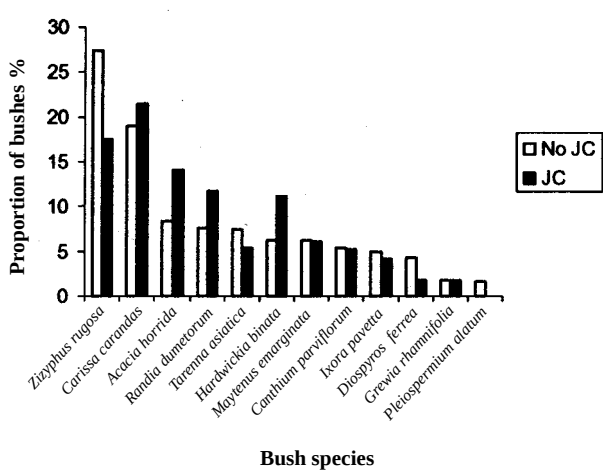


Fig 7.: Mean percentage composition of trees and bushes in 10 m square vegetation survey plots which contained tracking strips from which tracks of Jerdon's Courser (JC) were (filled bars) or were not (open bars) recorded. Species are presented from left to right in order of descending overall abundance.

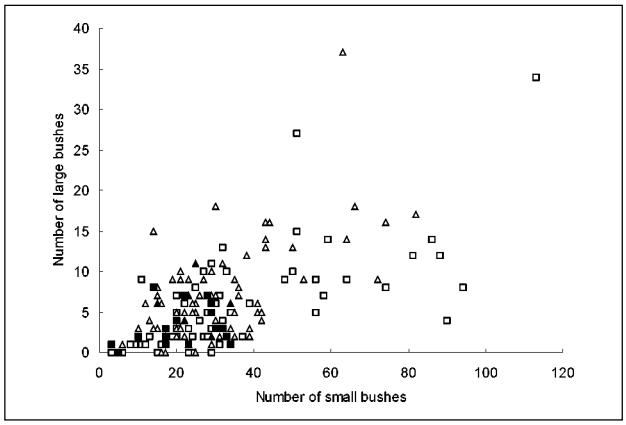


Fig. 9: Numbers of large (>2 m high) and small (<2 m) bushes in 10 m square vegetation survey plots centred on 157 tracking strips. Each point represents a plot. Filled symbols denote plots that contained strips from which tracks of Jerdon's Courser were recorded and open symbols strips where they were not recorded. Squares represent plots with scores of the third principal component of vegetation composition (PC3) below the median and triangles represent plots with PC3 scores at or above the median.

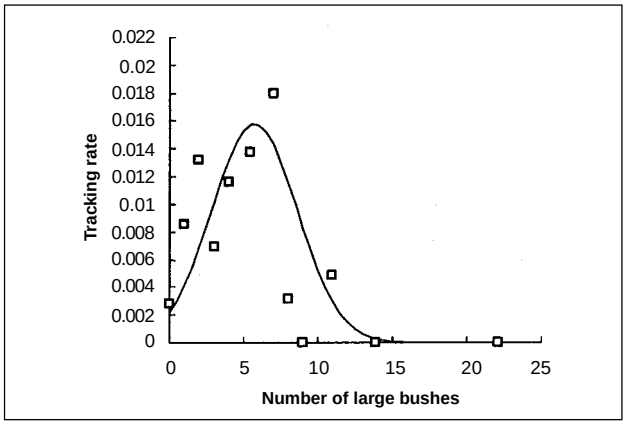


Fig 10.: Number of Jerdon's Courser tracking events per strip-night in relation to the number of large (>2 m high) bushes in a 10-m square plot centred on the tracking strip. Plotted points are for groups of bush number categories, which were grouped so that no bin contained data for less than 300 strip-nights. The curve is from the logistic regression model.

tracked than untracked sites and higher abundances of *Acacia horrida*, *Randia dumetorum* and *Hardwickia binata*. These differences are in accord with the correlations of these species with PC3 score (Table 4) and the negative effect of PC3 score on tracking rate.

DENSITY OF LARGE BUSHES IN RELATION TO SATELLITE IMAGE DATA

The effect of the density of large bushes on tracking rate was highly significant. Accordingly, we carried out a two-step analysis in which we first modelled the density of large bushes using satellite data and then related tracking rate to estimated large bush density. This approach was considered to be potentially valuable in facilitating the mapping of suitable habitats for Jerdon's Courser in other areas (Jeganathan *et al.* 2004)

DISCUSSION

Jerdon's Coursers were most likely to occur in areas of scrub jungle with intermediate densities of large bushes. There was a significant correlation between the density of large bushes and band 7 reflectance ($r = -0{\cdot}462$; $P < 0{\cdot}001$). The fact that band 5 and 8 reflectances, rather than band 7 reflectance, were selected as the best correlates of bush density is a result of high correlations among the reflectances for bands 5, 7 and 8 (Table 6). Hence, the vegetation- and satellite imagery-based models both support a strong effect of the density of large bushes. Densities of about 300–700 large (> 2 m tall) bushes ha $^{-1}$ and less than 1000 small (< 2 m) bushes ha $^{-1}$ are likely to be favorable to Jerdon's Coursers. Therefore, the clearing of scrub forest by people, over grazing by livestock and probably under

***Table 5**. Means and standard errors (italics) in survey blocks for counts of bushes, percentage cover of substrate types and grass, proportion of plots in which there was evidence of wood cutting (Cut) and the first three principal components from an analysis of the species composition of trees and bushes. Means for all plots containing strips with and without Jerdon's Courser (JC) records are also shown. Sample sizes are given in Table 3.*

Block	Small bushes		Large bushes		Stones		Gravel		Soil		Grass		Cut	PC1		PC2		PC3	
A	25.4	*2.3*	4.1	*0.9*	80	*5*	0	*0*	20	*5*	61	*4*	0.93	-0.80	*0.09*	-0.40	*0.17*	1.08	*0.19*
B	24.6	*2.7*	4.5	*0.8*	95	*9*	0	*0*	41	*9*	64	*3*	0.94	-0.32	*0.13*	-0.86	*0.12*	0.34	*0.23*
C	20.8	*3.6*	4.9	*1.2*	20	*7*	8	*8*	71	*10*	69	*7*	0.83	0.28	*0.21*	-0.60	*0.25*	-0.19	*0.23*
D	47.6	*4.6*	10.8	*1.6*	19	*6*	0	*0*	81	*6*	57	*4*	1.00	1.52	*0.28*	0.49	*0.23*	0.05	*0.17*
E	39.8	*8.3*	10.4	*2.6*	46	*11*	0	*0*	54	*11*	56	*3*	1.00	0.20	*0.34*	0.43	*0.20*	-0.10	*0.18*
F	36.3	*3.2*	8.8	*2.3*	30	*10*	18	*8*	53	*10*	38	*4*	0.87	0.37	*0.24*	-0.18	*0.24*	0.72	*0.21*
G	33.7	*7.9*	4.8	*1.4*	33	*13*	9	*9*	58	*14*	37	*8*	1.00	0.45	*0.20*	0.05	*0.24*	-0.25	*0.31*
H	19.0	*3.0*	3.4	*0.9*	13	*4*	6	*6*	81	*7*	64	*4*	0.61	-0.18	*0.14*	-0.60	*0.21*	-1.01	*0.18*
I	21.3	*2.2*	3.4	*0.6*	31	*6*	0	*0*	69	*6*	63	*5*	0.75	0.10	*0.20*	0.02	*0.13*	-0.48	*0.26*
J	20.8	*2.7*	6.4	*1.4*	61	*12*	6	*6*	34	*12*	72	*5*	0.80	-0.70	*0.16*	-0.05	*0.15*	0.60	*0.19*
K	48.0	*6.3*	8.2	*1.1*	65	*7*	4	*4*	31	*7*	64	*6*	1.00	-0.96	*0.08*	1.71	*0.13*	-0.38	*0.24*
No JC	32.6	*1.8*	6.7	*0.5*	42	*3*	4	*2*	54	*3*	60	*2*	0.89	0.04	*0.09*	0.02	*0.09*	0.10	*0.08*
JC	21.7	*1.9*	3.9	*0.6*	34	*7*	5	*4*	62	*8*	55	*5*	0.83	-0.22	*0.15*	-0.12	*0.18*	-0.56	*0.22*

Table 6. *Pearson correlation coefficients among Landsat band reflectance values and NDVI scores in 157 pixels containing tracking strips and centres of vegetation survey plots.*

	NDVI	Band 1	Band 2	Band 3	Band 4	Band 5	Band 7	Band 6.1	Band 6.2
NDVI									
Band 1	-0.679								
Band 2	-0.777	0.807							
Band 3	-0.914	0.714	0.878						
Band 4	-0.087	0.284	0.470	0.472					
Band 5	-0.729	0.697	0.836	0.858	0.528				
Band 7	-0.790	0.683	0.834	0.891	0.466	0.969			
Band 6.1	-0.509	0.408	0.578	0.596	0.387	0.617	0.583		
Band 6.2	-0.530	0.429	0.564	0.604	0.370	0.634	0.595	0.873	
Band 8	-0.604	0.551	0.711	0.777	0.606	0.717	0.715	0.472	0.477

Moderate amount of cattle grazing and wood cutting may keep the scrub jungle habitat suitable for the Jerdon's Courser

grazing too, are all likely to cause deterioration in habitat for this species.

This model was used for classifying each pixel on the image (Fig. 11) into suitable or non-suitable habitat using clustering algorithm. From this analysis a preliminary level habitat suitability map of the Jerdon's Courser was produced (Fig 12) using ERDAS image processing software. This algorithm classified the known Jerdon's Courser area (scrub jungle), water body, thick-forested areas and human habitations appropriately. Ground verification of this model output suggests inclusion of some agricultural land and forested hills as suitable. We presume that this is due to the similarity of the reflectance values of these features to that of the scrub jungle habitat. It should be noted here that the elevation was not included as a parameter in this model.

These false positives in the model output can be eliminated if they are combined with the wide range of ground-truthed data from different land cover features. In order to find the actual Jerdon's Courser suitable habitat through this model output, we have to crosscheck with False Color Composite and Survey of India toposheets. This will eliminate the false positives shown in the model output such as in the hill faces and agricultural areas.

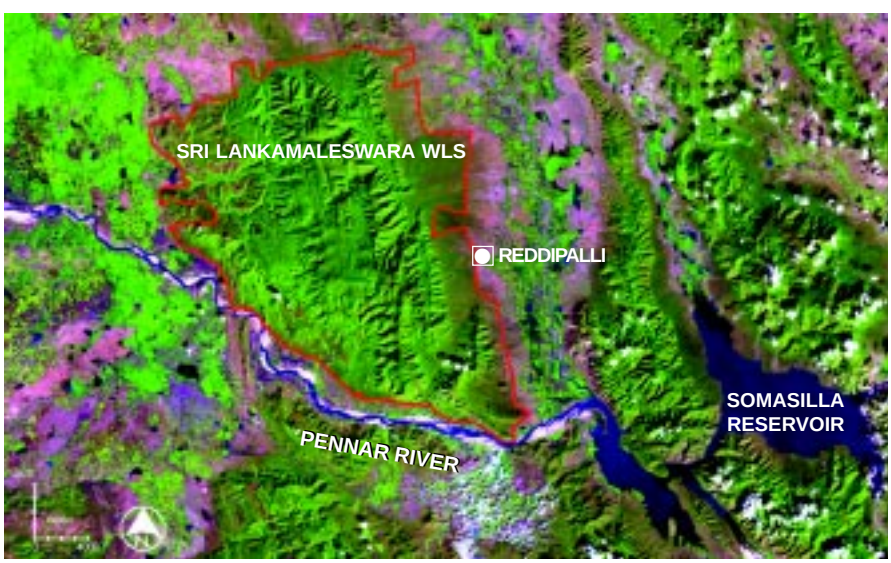


Fig 11.: Satellite imagery shows the major geographical features in and around the study area

A view of Somasilla Reservoir. Several villages were displaced from this area and relocated near the Sri Lankamalaswara Wildlife Sanctuary

A view of Pennar river valley

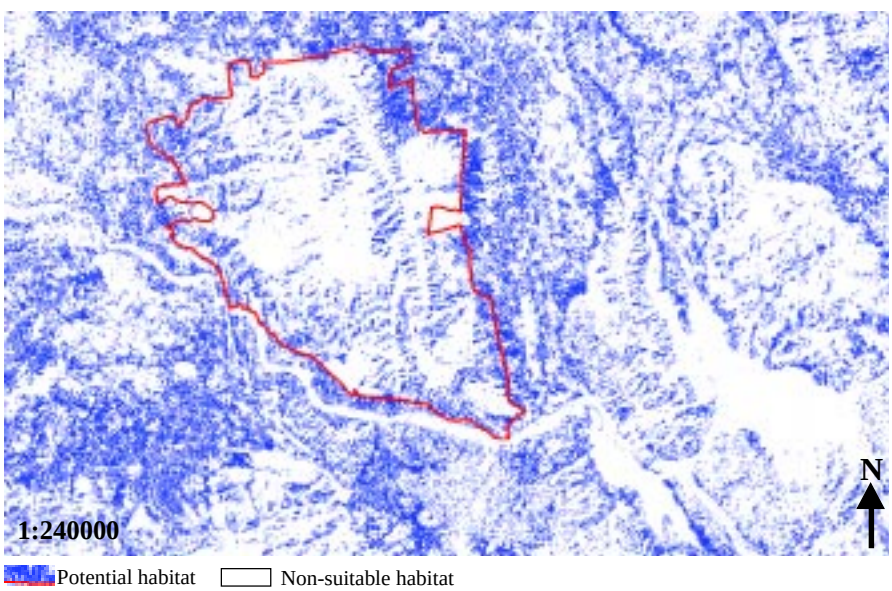


Fig 12.: Preliminary habitat suitability map of the Jerdon's Courser in and around the Sri Lankamaleswara Wildlife Sanctuary.

CHAPTER 6

CONSERVATION ISSUES AND RECOMMENDATIONS

METHODS

DOCUMENTING AND MAPPING THE DISTURBANCES

Scrub jungle with open areas, which are potentially suitable habitat of the Jerdon's Courser have been cleared and developmental activities have taken place in and around the Sanctuary area during the study period. All these anthropogenic activities were recorded and the places where such activities occurred were marked using GPS. Potentially suitable habitat of the Jerdon's Courser was mapped with the help of satellite imagery. Extent of the area cleared was mapped by walking along the edge of the cleared areas with GPS. Map of the cleared areas was kept as an overlay on the imagery to find out the extent of the loss of suitable habitat. This was achieved with the help of Arc View GIS 3.2a software.

RESULTS

SCRUB JUNGLE CLEARANCE

A large area of the scrub jungle was cleared during the study period (2001-04) in and around the Sri Lankamaleswara Wildlife Sanctuary. Totally about 332 ha. was cleared during this period. Of this, nearly 85 ha. of the scrub jungle, which is potentially suitable for the Jerdon's Courser, had been cleared to provide land for agriculture to the people who were displaced by floods, and also for lemon farming. These cleared places fall within about 1 Km from the previously known as well as newly detected Jerdon's Courser areas (Table 7 and Fig. 13).

***Table 7**: Location, extent of clearance and distance to the nearest Jerdon's Courser record*

Location	Area cleared (in hectares)	Nearest Jerdon's Courser record (in metres)
14° 36′ N, 79° 01′ E	303.25	580 *
14° 34′ N, 79° 01′ E	4.72	310 *
14° 38′ N, 79° 02′ E	13.75	840 *
14° 33′ N, 79° 01′ E	10	990
TOTAL	331.72	

* Records from outside the Sanctuary area

DEVELOPMENTAL ACTIVITIES INSIDE THE SANCTUARY

Construction of check dams, percolation ponds and digging of trenches inside the Sanctuary are threats to the natural scrub jungle habitat. During the study, these activities have occurred in areas where Jerdon's Courser was already known to be present and also near some of the places where we have detected the presence of the species recently. Trenches are mapped by walking inside the trench and marking their starting and ending points using the GPS. The trenches start from the boundary of the Sanctuary and

Lot of scrub jungle vegetation was cleared very close to the Jerdon's Courser area.

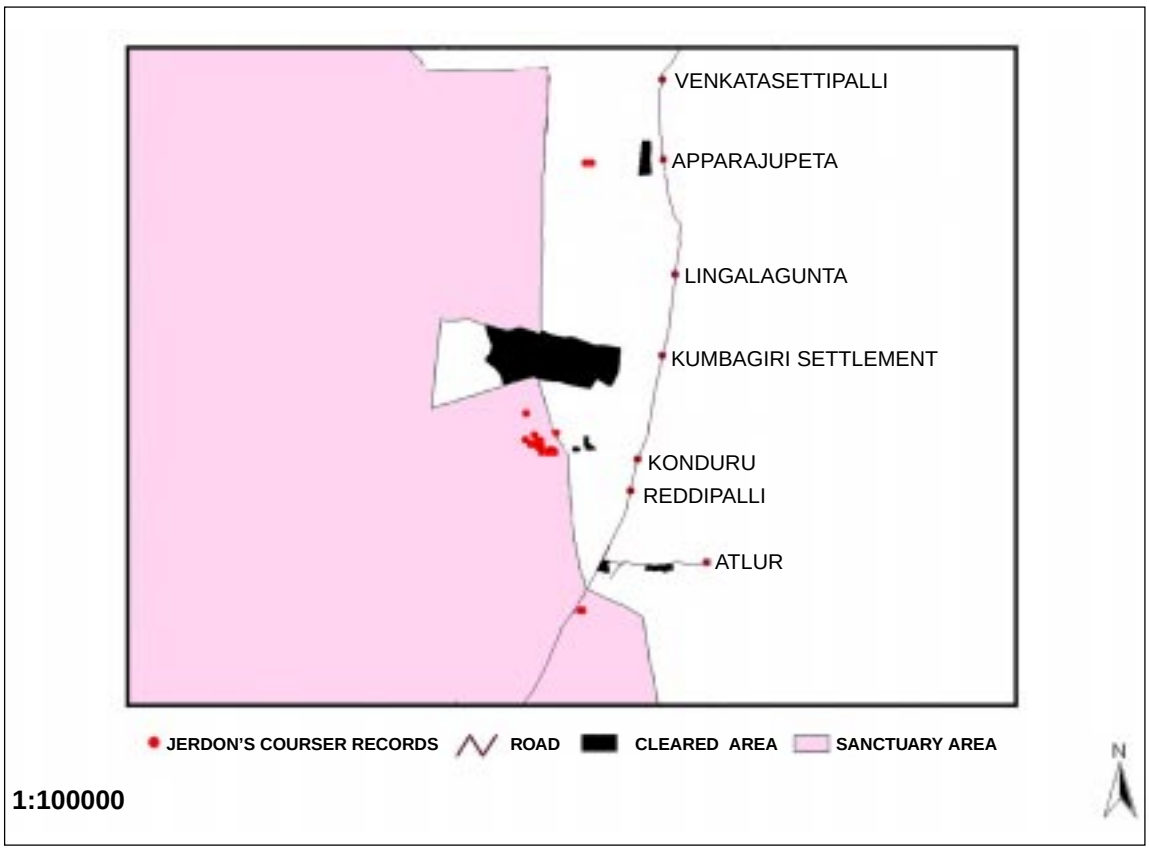


Fig. 13.: Scrub Jungle clearance and the Jerdon's Courser records

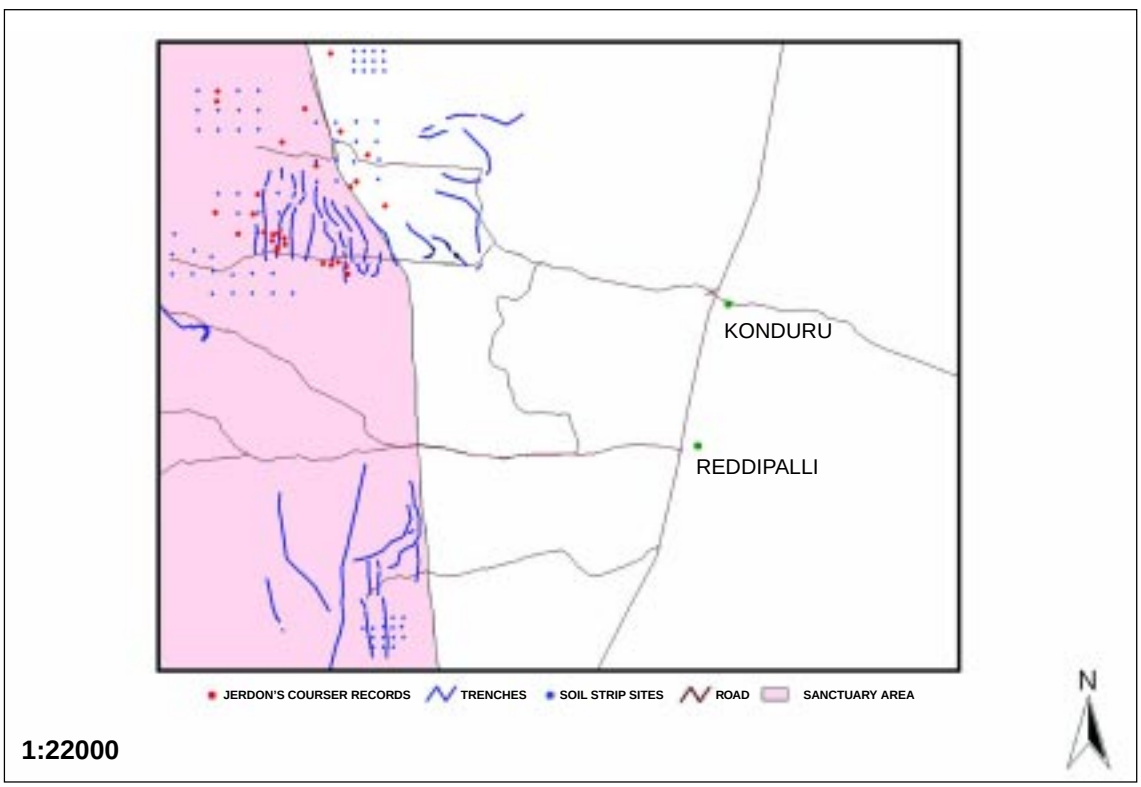


Fig. 14.: Map showing the Jerdon's Courser records and trenches in and around the Sri Lankamaleswara WLS

extend up to the place where there are records of Jerdon's Courser (Fig. 14). The boundary is also demarcated by the trench, which runs along, major part of the Sanctuary.

Trenches may affect the uniqueness of the scrub jungle habitat

MEASURES TAKEN BY THE PROJECT TEAM

All these threats were documented in the form of reports which consider the habitat destruction, location where it has taken place, and possible impact. These reports were sent to the Andhra Pradesh Forest Department immediately. As a result, further developmental activities were stopped, especially in the places where there are recent records of the Jerdon's Courser. Also, through seminars and training programmes, the importance of keeping the scrub jungle habitat intact and the impact of habitat destruction on the Jerdon's Courser were emphasised.

RECOMMENDATIONS

LARGE SCALE HABITAT MAPPING

To gather information on the spatial location of potentially suitable habitats in the places where the Jerdon's Courser has been reported historically, it is important to do large-scale habitat mapping. Bhushan (1994), Samant and Elangovan (1997) suggested localities of the presence of the species at confirmed and suspected sites in Andhra Pradesh. Satellite images of the corresponding areas should be analysed and classified. This would enable the establishment of new protected areas.

SURVEY TO FIND THE JERDON'S COURSER IN NEW AREAS AND LONG-TERM MONITORING

Surveys should be carried out in the places where there are confirmed and suspected records of the Jerdon's Courser by following the soil strip and tape playback methods. Surveys should also be carried out in the areas, which are identified from the satellite images through large-scale habitat mapping. Suitable habitats within the Sri LankamaleswaraWildlife Sanctuary should be monitored in the long-term, for effective management.

PROTECTION FOR THE JERDON'S COURSER HABITAT OUTSIDE THE SANCTUARY

Jerdon's Courser was detected in three new places during this study, and one of these sites is well outside the sanctuary border. Additionally, even near the known Jerdon's Courser areas, there are few records outside the Sanctuary border. Large areas of potential habitat are present outside the Sanctuary. The absence of Jerdon's Courser records does not imply the absence of these birds because most of the areas outside the Sanctuary have not been surveyed yet. So it is imperative to protect the potentially suitable habitat outside the Sanctuary also.

Preliminary analysis of the satellite image reveals that there are lots of areas within the coverage of the imagery (c. 180 sq/km) classified as potentially suitable habitat for the Jerdon's Courser. This image covers most of the Cuddapah district. Except for one Sanctuary, the rest of the suitable habitats are not protected.

The Wildlife (Protection) Act, 1972, amended in 2003, says that the State Government is empowered to declare any area owned by the Government near the Sanctuary as a "Conservation Reserve" to protect the important habitat for flora and fauna. Also if the area belongs to private people or community and if they are willing to conserve the wildlife and its habitat, the State Government is empowered to declare such an area as a "Community Reserve". We suggest that the possibility of declaring Community Reserves and/ or Conservation Reserves should be explored with the help of local communities and stakeholders.

Scrub jungle habitat has been cleared mainly for Sweet Lime farming in recent times around the Sri Lankamaleswara WLS

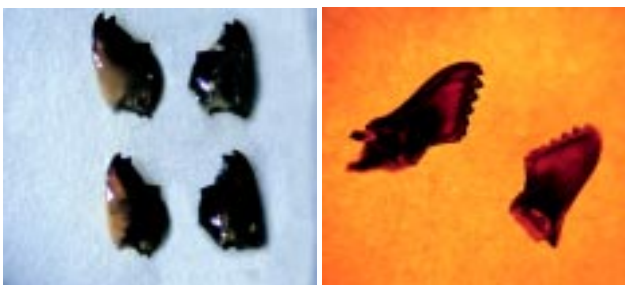
RADIO TELEMETRY STUDIES

Nothing is known about the population, ecology and behaviour of the Jerdon's Courser (BirdLife International 2001). The more we know about their habitat requirements, the sooner and more effectively can we conserve them.

Radio tracking would reveal information about the ranging behaviour, from which detailed maps of their movements can be produced.

Through radio tracking we can also gain knowledge about their feeding areas, roosting sites, and nest sites. Two samples of Jerdon's Courser droppings were collected during this study. It was found that these droppings consist mainly of body parts of *Macrotermes* termites and ants.

Radio tracking will also help in locating faecal material for diet analysis once the bird has left the roost site. It would be helpful to determine whether this species' distribution is limited by the availability of a particular food species.



Mandibles of termites and ants found in the droppings of the Jerdon's Courser

Nothing is known of the breeding ecology of Jerdon's Courser (BirdLife International 2001), no nests or young birds have ever been found. Though we have no direct evidence, the observation of the footprints of a young bird along with an adult Jerdon's Courser in one of the soil strips we deployed, suggests successful breeding in our study area.

The usual way to locate the nests of ground-living birds is to observe an adult until it returns to its nest (Bibby *et al.* 2000). This is impossible in the case of the Jerdon's Courser, since it is nocturnal. The only way to locate nests would be to radio-track individuals.

Radio tracking would also help to develop more efficient survey methods. For instance, it would be possible to measure the proportion of occasions on which radio-tagged Jerdon's Coursers respond to tape recordings and whether they only do so at certain times of the year.

It is possible to estimate the number of individuals present in an area by measuring the ratio of untagged to tagged individuals responding to tape playback (Bibby *et al*. 2000). Since the number of tagged individuals is known, the total number of individuals present could be obtained using this ratio. It would also be possible to measure the proportion of occasions on which a radio-tagged Jerdon's Courser responds to tape playback by calling when it is within 250 metres. This estimate of survey efficiency would be useful to convert the results of tape transects directly to density estimates. Once density has been estimated in this way for a few study areas it would be possible to calibrate the soil strip tracking method so that the relationship between tracking rate and density is known. Hence, radio-tracking Jerdon's Courser would help in assessing population size, as well as range.

Plaster cast of the footprint of the young and adult Jerdon's Courser

Radio tags which are less than 2% of the body mass of the Jerdon's Courser can be fitted on the bird's back to reveal information of its ecology

It is possible that individual Jerdon's Coursers occupy a home range within a known area for only some part of the year. Birds may migrate to other areas or habitats at different times of year. This possibility can only be investigated by radio-tracking.

Radio tracking would reveal information about the Jerdon's Courser that could not be gained in any other survey techniques employed by the project during this study. The information gained from radio tracking would be of direct and immediate value for remedial management intervention.

CHAPTER 7

CAPACITY BUILDING AND PUBLIC AWARENESS WORKSHOPS

Workshop in Hyderabad in January 2003

The first major training was a one-day workshop held in Hyderabad, in January 2003. This meeting was organised by Bombay Natural History Society (BNHS) and the Andhra Pradesh Bird Watching Society in order to disseminate to a wide audience the findings of the Jerdon's Courser project and to discuss its implications. Both national and Andhra Pradesh Forest Department officials involved in wildlife conservation attended the meeting along with representatives from NGOs such as WWF-India and Centre for Environmental Education (CEE). The meeting involved a series of talks given by the Jerdon's Courser project team reviewing the progress of the project.

The main outcome of the meeting was:

(1) General proposals to consider training local forestry department staff in field methods used to census Jerdon's Courser and,

(2) A proposal to develop radio-tracking studies on Jerdon's Courser.

TRAINING WORKSHOP ON CENSUSING AND DEMONSTRATION OF RADIO TAGGING METHOD ON BIRDS

A one-day workshop was organised in Cuddapah for Andhra Pradesh Forest Department officials on August 29, 2003. The workshop was organised by BNHS, and around 90 forest officials including Forest Rangers, Foresters and Guards participated. The meeting involved talks, as well as field demonstrations, on the censusing and radio tagging methods for birds.

The Jerdon's Courser project team explained the results of the studies based on intensive research and emphasised why it is important to radio-track the Jerdon's Courser, and gave examples of how useful, widespread and safe radio-tracking is.

In the field, two Red-wattled Lapwings were trapped, fitted with radio-tags and released. Participants involved in the workshop then tracked them for a short time. Preparation of soil strips and plaster casting of the footprints were also demonstrated to the forest staff. Finally, part of the group including senior officials listened for a Jerdon's Courser in a place where it was known to occur. As a consequence of this workshop, the Andhra Pradesh Forest Department forwarded a proposal to grant permission to radio tag the Jerdon's Courser to the Ministry of Environment and Forest, Government of India.

Mr. A.V. Joseph, DPCCF releasing one of the Red-wattled Lapwing, which was radio-tagged during the workshop in Cuddapah in August 2003

A Red-wattled Lapwing radio tagged during the workshop

PUBLIC AWARENESS

Public awareness initiatives have tended to be reactive rather than following a strict timetable. This is because opportunities to talk to the media, or to promote the project are usually linked to other events such as workshops, training programmes and local heritage festivals. Such events were used for publicising the project as widely as possible. The Jerdon's Courser project team was interviewed after the workshop in Hyderabad, and a story on Jerdon's Courser appeared in one of India's national newspapers, *The Hindu* (February 13, 2002). Training for censusing the Jerdon's Courser and demonstration of radio tagging method held in Cuddapah, were widely covered by newspapers, both in Telugu and English, and also by local television channels. Each year in Cuddapah District, a festival is held to celebrate the heritage of the area. In 2004, the logo for this festival was the Jerdon's Courser. Four popular science articles explaining the recent efforts to conserve the Jerdon's Courser were published in newsletters and magazines such as *Mistnet*, Vol.3 (1) 2002, *Hornbill* (April-June, 2002), *World Birdwatch*, Vol. 24 (4) (December, 2002), and *Sanctuary Asia* (February, 2004).

SOUND MODULE

The project team has designed a small sound box, which reproduces the call of the Jerdon's Courser. These boxes were distributed together with a brochure, that briefly explains the aim of the project, call listening procedures, and contact details of the field team. It was distributed among birdwatchers, forest department officials and local people and was intended to encourage them to report potential contacts with Jerdon's Courser that could then be investigated further by the field team. To start with, the boxes were distributed widely in Cuddapah district, Andhra Pradesh. Telugu and English national newspapers covered this event as well.

Sound boxes with the call of the Jerdon's Courser have been distributed widely in Cuddapah district

Along with the sound box, brochures in the local language (Telugu) with details about Jerdon's Courser calling behaviour was also distributed

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Safe habitat for endangered "jerdon's courser" sought

By Our Staff Reporter

CUDDAPAH, AUG. 29. The conservation of environmental biodiversity and recreating a conducive habitat for ensuring the visit of the critically endangered 'jerdon's courser', known locally as 'kalivi kodi' which frequents Reddipalle village and Sri Lankamlleswara Sanctuary near Rachvel in Cuddapah district was stressed at a training programme organised by Bombay Natural History Society here on Friday.

Addressing participants on 'surveying the critically endangered jerdon's courser and demonstration of radio-tagging method on birds' at Sabha Bhavan, the Chief Conservator of Forests, A.V. Joseph, said Jerdon's Courser (rhinoptilus bitorquatus), the rarest and least known bird in the world, which frequented the sanctuary in Cuddapah district, should be projected to tap the tourist potential and people enlightened on the bird's significance and rarity. He called upon the forest officials to ensure a conducive habitat to prevent them from becoming extinct.

The bird was elusive and was rediscovered after a gap of eight years and hence detailed studies on it could not be performed, he said. The number of Jerdon's Courser gender-wise and their feeding and breeding practices were yet to be explored, he said. The Collector, Jayesh Ranjan, could declare the areas being visited by the rare bird as community conservation centres or reserves to ensure its protection, he advised. The International Research Biologist of the Royal Society for the Protection of Birds, U.K., Christopher G.R. Bowden, released an informative and colourful poster on jerdon's courser. He said environmental changes in the sanctuary area was causing concern. He gave a presentation on radio-tagging of wild birds.

The Jerdon's Courser Project Field Researcher of BNHS, Panchapakesan Jegannathan, who gave a slide show presentation, said that the bird was discovered by T.C. Jerdon in 1848 and its presence was detected in Cuddapah, Anantapur district and the Government river valley areas. The renowned ornithologist, Salim Ali, too conducted a study on it in 1933-34, but the bird was not traced between 1930 and 1986, although members of the BNHS, World Wild Life, Smithsonian Institute and University of Cambridge made intensive efforts.

A Newspaper clipping (The Hindu August 30, 2003) highlights the importance of the Jerdon's Courser habitat outside the Sanctuary

Back cover photographs:

1. **Mechanical clearance of scrub jungle to create orchards, pastures and quarrying on hills are threatening the suitable habitat of the Jerdon's Courser**

2. **Clearing the scrub jungle habitat for sweet lime farming is increasing in and around the Sri Lankamaleswara WLS**

3. **Survival of the Jerdon's Courser is threatened by destruction of its suitable habitat by various anthropogenic activities.**

4. **Over grazing may result in deterioration of the scrub jungle habitat**

5. **Percolation pond inside the Sanctuary. Inappropriate management may affect the scrub jungle habitat**